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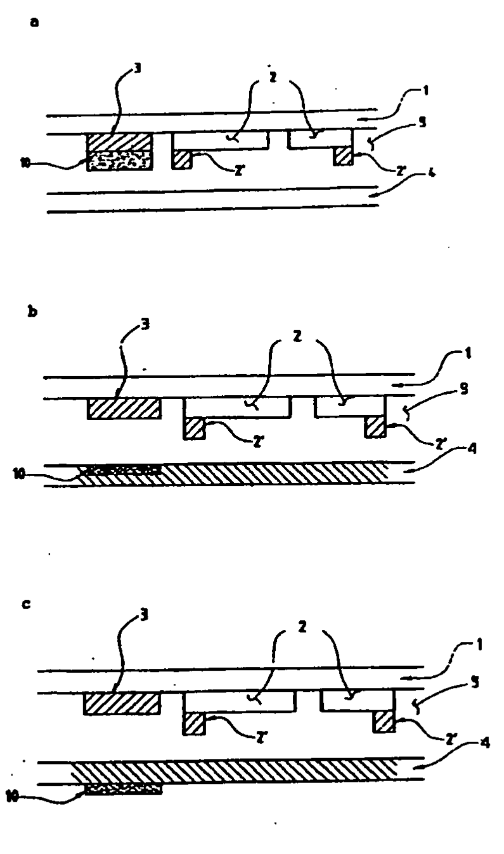

(57) Abstract: The present invention provides a plasma display panel with an improved radiation efficiency and brightness by preventing an inefficient consumption of ultra-violet rays. The plasma display panel is characterized in that an ultraviolet-emitting phosphor film, (10, 15', 15, 16, 17) is formed on at least one of the black stripe layer (3), the front dielectric layer (9), a protective MgO layer (4), the barrier ribs (5) and the surface or interface of the rear dielectric layer (7).

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PLASMA DISPLAY PANEL WITH IMPROVED RADIATION EFFICIENCY AND BRIGHTNESS

BACKGROUND OF THE INVENTION

The present invention relates to a plasma display panel (PDP), and more particularly to a plasma display panel which can prevent an inefficient consumption of ultra-violet rays generated during discharge of xenon (Xe) gas by forming a phosphor film emitting ultraviolet rays of a short/long wavelength on a surface, interior or interface of respective elements (black stripe(BS) layers, dielectric layers, barrier ribs) disposed on a front substrate or a rear substrate of the panel, or by containing ultraviolet-emitting phosphor particles of a short/long wavelength in the respective elements, thereby improving a light-emitting efficiency and luminance of phosphor particles in a surface discharge type plasma display panel.

Fig. 1 illustrates a schematic partial sectional view of a conventional plasma display panel. As shown in Fig. 1, the plasma display panel comprises a front substrate 1 and a rear substrate 8 faced parallel to the front substrate 1 wherein the front substrate is provided with a front electrode group

consisting of X-sustain electrodes and Y-sustain electrodes as transparent electrodes, a dielectric layer and a protective MgO layer formed thereon. And the rear substrate 8 is provided with address electrodes as data electrodes, a dielectric layer 7 and a phosphor film 6 formed between barrier ribs 5.

In an illustrative method of driving the plasma display panel, one frame is divided into six subframes and each subframe is set to have different sustain periods. Then, a gray scale display of an image screen is obtained by combining each subframe. Each subframe has a reset period, an address period and a sustain period. During the reset period, a write pulse is applied to the X-sustain electrodes connected commonly to each other in order to equalize or initialize discharge conditions of all cells of the panel, thereby totally discharging all cells. A sustain pulse is applied to Y-sustain electrodes in order to sustain the discharge and then an erasure pulse is applied to the X-sustain electrodes in order to erase wall charges accumulated on the dielectric layer. During the address period, wall charges are accumulated on the front dielectric layer 9 of cells to be displayed by applying data pulses into the address electrodes in order to selectively

address cells to be displayed depending on inputted image data and sequentially applying a scan pulse into the Y-sustain electrodes. Then, by applying alternately the sustain pulse to X-sustain electrodes and Y-sustain electrodes, the cells which were addressed during the address period (that is, having a wall charge accumulated thereon) are discharged.

In a reset period and an address period in the course of displaying one subframe as discussed above, the address electrodes are maintained at the reference level, that is, a ground level, equal to that of the X-sustain electrodes and Y-sustain electrodes, as the result of which space charges and wall charges may be generated, thereby to facilitate writing and erasure operations necessary for discharging. Alternatively, in the sustain period, the address electrodes may be maintained at a high impedance, not at the ground level and, in this time, a voltage is induced to the address electrodes by the space charges formed on the electrode group in the front substrate. As a matter of convenience, a floated address voltage is referred to as an induced voltage. During the sustain discharge, the induced address voltage to be maintained at the ground level may cause the

instability of the sustain discharge. Therefore, in a surface discharge structure of a plasma display panel, the induced sustain voltage is typically maintained at the high impedance.

In the conventional surface discharge type AC-PDP as discussed above, an ultraviolet ray which is generated during discharge of Xe gas and has a peak wavelength of 147nm or 172nm,, etc., is emitted to the phosphor particles exposed directly to a discharge space(X) so as to emit visible light. However, there exists a disadvantage that only a small amount of the ultra-violet ray serves to emit visible light from the phosphor particles, while the remaining significant amount thereof is absorbed by the elements in the front substrate and the rear substrate or passes through them, resulting in an inefficient consumption of the ultra-violet ray.

That is, as shown using arrows in Fig. 1, a small amount of the ultra-violet ray (UV) emitted into the discharge space is used to emit visible light from the R, G, B phosphor particles, the remainer is inefficiently consumed as described above.

As an example for improving such a disadvantage, Japanese patent laid-opened publication No. Hei

9-263756(publication date of October 7, 1997) discloses a phosphor and color plasma display panel, in which a phosphor film of R, G and B phosphors is formed by mixing an ultraviolet emitting phosphor having a long wavelength (200-400nm) under irradiation of an ultraviolet ray having a peak wavelength of 147nm or 172nm (a wavelength of 200nm or below) generated in a discharge space (X) with visible-light-emitting phosphors (R, G and B). In accordance with this technique, in order to improve a light emitting efficiency of phosphor, an ultraviolet-emitting phosphor is irradiated by an ultraviolet ray having a peak wavelength of 147nm or 172nm generated from the discharge space(X) and then emits an ultraviolet ray having a long wavelength of 200 - 400nm, exciting more visible-light-emitting R, G and B phosphors. However, this technique has a disadvantage that, because the visible-light-emitting R, G and B phosphors are mixed with an ultraviolet-emitting phosphor having a long wavelength, phosphor particles emitting an ultraviolet ray having a long wavelength (200-400nm) under irradiation of an ultraviolet ray having a peak wavelength of 147nm or 172nm generated from the discharge space (X) may prevent a light path of the ultraviolet ray having a peak

wavelength of 147nm or 172nm which is directly effective under an excitation of the visible-light-emitting R, G and B phosphors.

SUMMARY OF THE INVENTION

Accordingly, in order to the above discussed problems, an object of the present invention is to provide a plasma display panel which can prevent an inefficient consumption of an ultraviolet ray generated during discharge of xenon (Xe) by forming an ultraviolet-emitting phosphor film having a short/long wavelength on an surface, interior or interface of respective elements (black stripe(BS) layers, dielectric layers, barrier ribs) disposed on a front substrate or a rear substrate of the panel or by containing ultraviolet-emitting phosphor particles having a short/long wavelength in the respective elements, thereby improving a light-emitting efficiency and luminance of phosphor in a surface discharge type plasma display panel.

In order to accomplish the object, in a plasma display panel having an improved light-emitting and luminous efficiency in accordance with a first embodiment of the present comprising a front electrode group consisting of X-electrodes and Y-electrodes formed on the rear surface of a front substrate; a black stripe

layer formed on the exterior of the X-electrodes and Y-electrodes; address electrodes formed on the interior surface of a rear substrate faced parallel to the front substrate so as to form a plurality of cells of discharge space at cross-points of the front electrode group; a front dielectric layer and a rear dielectric layer formed on the front electrode group and the address electrodes, respectively; barrier ribs formed on the rear dielectric layer at a predetermined spaced relationship and a phosphor film formed on the rear dielectric layer between the barrier ribs being characterized in that an ultraviolet-emitting phosphor film is formed on at least one of the black stripe layer, the front dielectric layer, a protective MgO layer, the barrier ribs and the surface or interface of the rear dielectric layer.

Accordingly, by emitting ultraviolet rays again by the inefficiently consumed ultraviolet rays from the discharge space, it is possible to allow the visible-emitting R, G and B phosphors to be excited more effectively, thereby improving the light-emitting efficiency and luminance of the phosphors. In case that the ultraviolet-emitting phosphor film was formed on the surface of the barrier ribs, black barrier ribs may be formed on

the ultraviolet-emitting phosphor film, wherein it is more effective to construct the ultraviolet-emitting phosphor film as a phosphor which emits an ultraviolet ray having a short/long wavelength of 400nm or below when irradiated by a ultraviolet ray having a short wavelength of 147nm or 172nm in its peak wavelength generated from the discharge space.

Also, it is desirable to form at least one of the black stripe layer, the barrier ribs and the rear dielectric layer as a mixed material with phosphor particles which emit an ultraviolet ray having a short/long wavelength of 400nm or below when irradiated by a ultraviolet ray having a short wavelength of 147nm or 172nm in its peak wavelength generated from the discharge space.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a cross sectional view schematically showing a structure of a conventional plasma display panel.

Figs. 2a through 2c are cross sectional views showing in detail a structure of a front substrate in accordance with preferred embodiments of the present invention.

Fig. 3 is a cross sectional view showing in detail a

structure of a front substrate in accordance with other embodiment of the present invention.

Fig. 4 is a cross sectional view showing in detail a structure of a rear substrate in accordance with a preferred embodiment of the present invention.

Fig. 5 is a cross sectional view showing in detail a structure of a rear substrate in accordance with other embodiment of the present invention.

Fig. 6 is a cross sectional view showing in detail a structure of a rear substrate in accordance with a still another embodiment of the present invention.

Fig. 7 is a cross sectional view showing in detail a structure of a rear substrate in accordance with a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

Figs. 2a through 2c depict cross sectional views showing in detail a structure of a front substrate in accordance with

preferred embodiments of the present invention.

First, with respect to the technical construction and operation of the present invention, as its principle, ultraviolet rays having a peak wavelength of 147nm, 172nm, etc., emitted during discharging of Xe are absorbed thereby to be emitted as a thermal energy, or outflown to the outside passing through the elements, thus, such ultraviolet rays do not allow phosphor particles to emit visible light. Therefore, in order to reuse such inefficiently consumed ultraviolet rays, phosphor particles (ultraviolet-emitting phosphor particles having a short/long wavelength), which emits a short/long wavelength of 400nm or below under irradiation of an ultraviolet ray having a short wavelength of a peak wavelength of 147nm or 172nm generated from the discharge space, are deposited on a surface, interior or interface of the respective elements(black stripe layer, barrier ribs and dielectric layer).

As a result, they absorb the ultraviolet ray emitted during discharge of Xenon (Xe) gas and emit ultraviolet rays having a short/long wavelength which allow visible light-emitting phosphors(R, G, B) to further emit visible light.

Materials of the phosphor emitting the short/long wavelength include $SrAl_{12}O_{19}:Ce$, $BaSi_2O_5:Pb$, $(Sr,Zn)MgSi_2O_7$, $SrB_4O_7:Eu$, etc.

Such phosphor can be used as a printing paste and a photosensitive paste by mixing it with a binder (EC-type, acryl-type binder, etc.) and a solvent(BC, BCA, terpineol, etc.).

Now, with respect to a process of the present invention, such a paste may be formed on the front substrate of the panel after forming the black stripe using a printing technique, and on each elements in the rear substrate of the panel after forming the dielectric layer and the barrier ribs, respectively. Alternatively, after formation of the barrier ribs, the paste may be coated at the same time on both surfaces of the dielectric layer and the barrier ribs using a printing technique.

In this time, its thickness may be equal to each other as to R, G and B cells, or controlled for the purpose of a control of color temperature. The thickness may be set to be ranged from several submicron to 20μm.

Also, a phosphor having a short/long wavelength may be doped on the interior of the barrier ribs or dielectric layer by

mixing the phosphor with the paste of the black stripe, barrier ribs or dielectric layer.

A completed structure of the front and rear substrate fabricated using such a process is shown in detail in Figs. 2a through 7.

As shown in Figs. 2a through 2c, ultraviolet-emitting phosphor film 10 is formed directly on the black stripe layer 3, between the front dielectric layer 9 above the black stripe layer 3 and the protective MgO layer 4 or on the protective MgO layer 4 above the black stripe layer 3 using a printing or a photosensitive processing technique. It is desirable that the ultraviolet-emitting phosphor film 10 is formed by the ultraviolet-emitting phosphor having a short/long wavelength described above.

In Fig. 3, there is formed a mixed black stripe layer 3 doped uniformly into the interior of the black stripe layer by mixing a black stripe with ultraviolet-emitting phosphors having a short/long wavelength. In this case, the mixed black stripe layer 3 may be formed using a printing or photosensitive processing technique.

Also, as shown in Fig. 4, after forming a rear dielectric layer 7 of the rear substrate 8, an ultraviolet-emitting phosphor film 17 is formed using a printing or photosensitive processing technique. Then, after forming the barrier ribs, an ultraviolet-emitting film 15 is formed.

As shown in Fig. 5, the ultraviolet-emitting film 15 is formed only between each of the barrier ribs 5, instead of the lower surface of the barrier ribs 5. Herein, the ultraviolet-emitting film 15 may be formed after forming the rear dielectric layer 7 and the barrier ribs 5.

In addition, as shown in Fig. 6, a mixed rear dielectric layer 7′ and mixed barrier ribs 5′ are formed on the rear substrate 8 by means of the mixed paste obtained by mixing a paste for coating the rear dielectric layer 7, barrier ribs 5 and the phosphor film 6 with ultraviolet-emitting phosphors having short/long wavelength using a printing or photosensitive processing technique. Alternatively, as described in Fig. 5, the mixed rear dielectric layer 7′ and mixed barrier ribs 5′ may be formed by doping the dielectric layer 7, barrier ribs 5 and phosphor film 6 and then penetrating the ultraviolet-emitting

phosphors therethrough.

In Fig 7, after forming white barrier ribs 5, an ultraviolet-emitting phosphor film 15′ is formed around the barrier ribs 5 using a printing or photosensitive processing technique. Black barrier ribs 5″ is then formed.

In the thickness, the above ultraviolet film 10, 15′, 15, 16, 17 may be formed to have different thickness depending on R, G and B phosphor cells. When mixed with the paste, the content of the ultraviolet-emitting phosphor may be mixed different depending on R, G and B phosphor cells. Also, although not illustrated, a combination of Figs. 2a through 7 may be formed.

Accordingly, in accordance with the present invention having such construction, it is possible to reuse the ultraviolet rays which have been consumed inefficiently due to the fact that a small amount of the ultraviolet rays (having a peak wavelength of 147nm, 172nm, etc.) generated from the discharge space in the surface discharge type AC-PDP only excites the R, G and B phosphors, while the remaining significant amounts thereof are converted to a thermal energy or emitted directly to the outside without being absorbing by the elements of the panel. That is, by

forming an ultraviolet-emitting phosphor film having a short/long wavelength on at least one of each surface, interior and interface of elements (black stripe layer, barrier ribs, dielectric layer) of cells, or by containing in the elements ultraviolet-emitting phosphors having a short/long wavelength, the ultraviolet rays having a short/long wavelength of 147nm, 172nm, etc., can be converted to ultraviolet rays having a short/long wavelength region (400nm or below) which allows R, G and B phosphor emitting visible light to be exited.

Consequently, such reuse of the ultraviolet rays improves the light emitting efficiency and luminance of a visible light-emitting phosphor.

In the construction and acting of the plasma display panel having an improved emitting light and luminance in accordance with preferred embodiments of the present invention, an inefficient consumption of ultra-violet rays generated during discharge of xenon (Xe) gas can be prevented by forming a phosphor film emitting ultraviolet rays having a short/long wavelength on each surface, interior or interface of elements including black stripes(BS) layer, dielectric layers, barrier ribs disposed on a

front substrate or a rear substrate of the panel or by containing phosphors emitting an ultraviolet rays having a short/long wavelength in the interior of respective elements, thereby resulting in an improvement of a light-emitting efficiency and luminance of R, G and B phosphors which emit visible light.

WHAT IS CLAIMED IS:

1. In a plasma display panel with an improved radiation efficiency and brightness comprising a front electrode group consisting of X-electrodes and Y-electrodes formed on the rear surface of a front substrate; a black stripe layer formed on the exterior of the X-electrodes and Y-electrodes; address electrodes formed on the interior surface of a rear substrate faced parallel to the front substrate so as to form a plurality of cells of discharge space in a crossing region with the front electrode group; a front dielectric layer and a rear dielectric layer formed on the front electrode group and the address electrode, respectively; barrier ribs formed on the rear dielectric layer and at a predetermined spaced relationship; and a phosphor film formed on the rear dielectric layer between the barrier ribs, said plasma display panel being characterized in that an ultraviolet-emitting phosphor film is formed on at least one of a surface or an interface of the black stripe layer, the front dielectric layer, a protective MgO layer, the barrier ribs and the rear dielectric layer.

2. A plasma display panel with an improved radiation

efficiency and brightness according to claim 1, wherein in case the ultraviolet-emitting phosphor film is formed on the surface of the barrier ribs, black barrier ribs are formed on the ultraviolet-emitting phosphor film.

3. A plasma display panel with an improved radiation efficiency and brightness according to claim 1, wherein the ultraviolet-emitting phosphor film is made of ultraviolet-emitting phosphors having a short/long wavelength of 400nm or below when irradiated by ultraviolet rays having a short wavelength of 147nm, 172nm, etc., in its peak wavelength generated from the discharge space.

4. In a plasma display panel with an improved radiation efficiency and brightness comprising a front electrode group consisting of X-electrodes and Y-electrodes formed on the rear surface of a front substrate; a black stripe layer formed on the exterior of the X-electrodes and Y-electrodes; address electrodes formed on the interior surface of a rear substrate faced parallel to the front substrate so as to form a plurality of cells of discharge space in a crossing region with the front electrode group; a front dielectric layer and a rear dielectric layer formed

on the front electrode group and the address electrodes, respectively; barrier ribs formed on the rear dielectric layer at a predetermined spaced relationship and a phosphor film formed on the rear dielectric layer between the barrier ribs, said plasma display panel being characterized in that at least one of the black stripe layer, the barrier ribs and the rear dielectric layer is formed of a material mixed with a phosphor having a short/long wavelength of 400nm or below when irradiated by a ultraviolet ray having a short wavelength of 147nm, 172nm, etc., in its peak wavelength generated from the discharge space.

FIG. 1

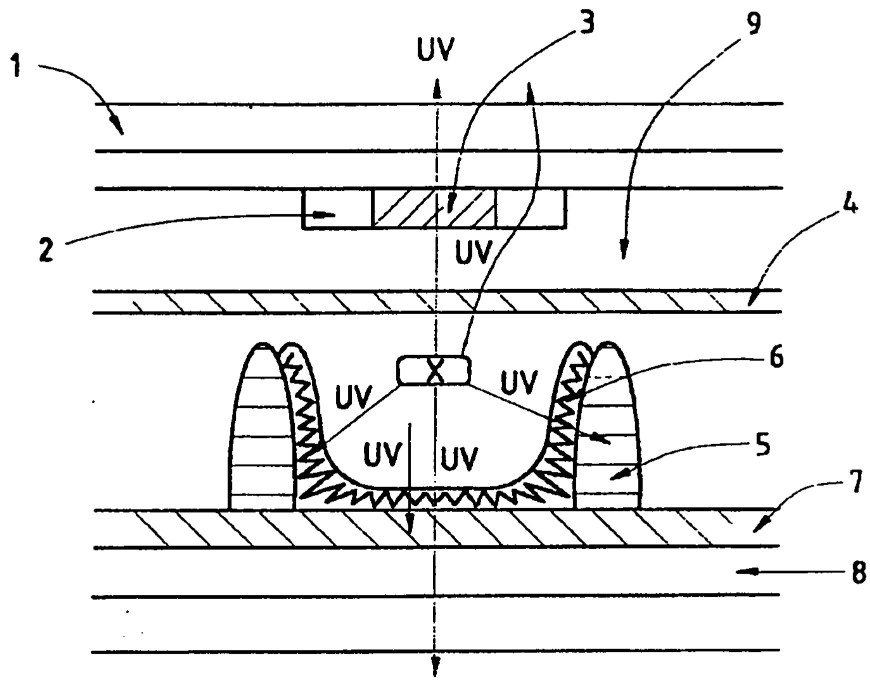


FIG. 2a

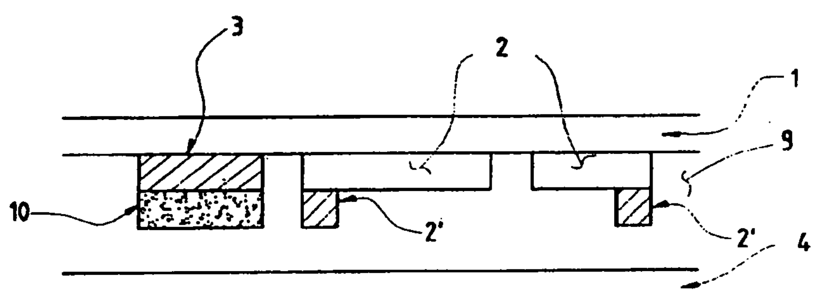


FIG. 2b

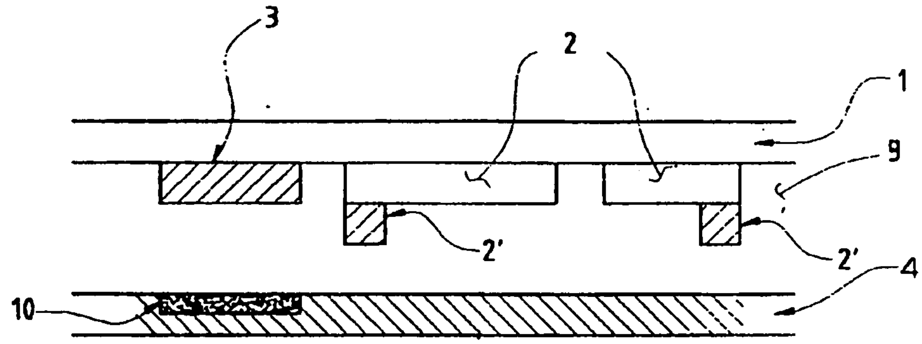


FIG. 2c

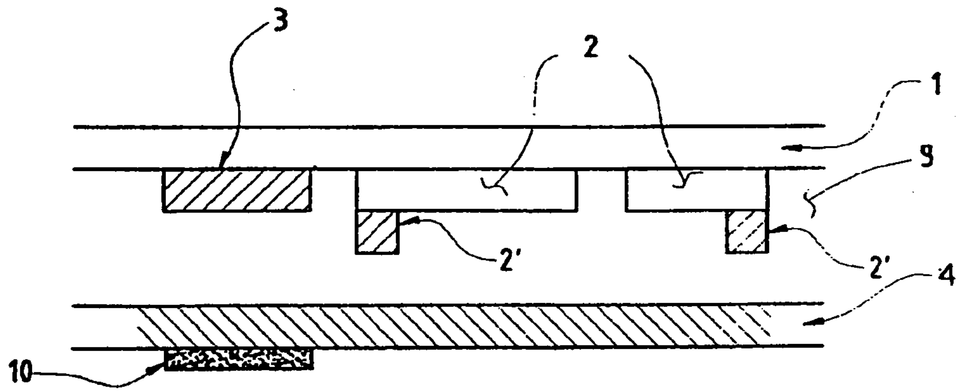


FIG. 3

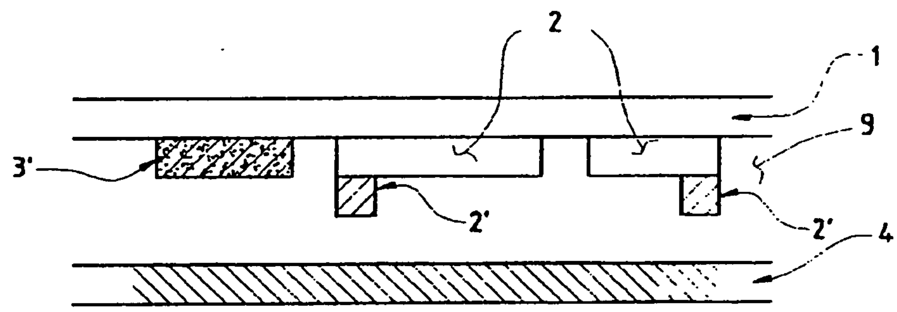


FIG. 4

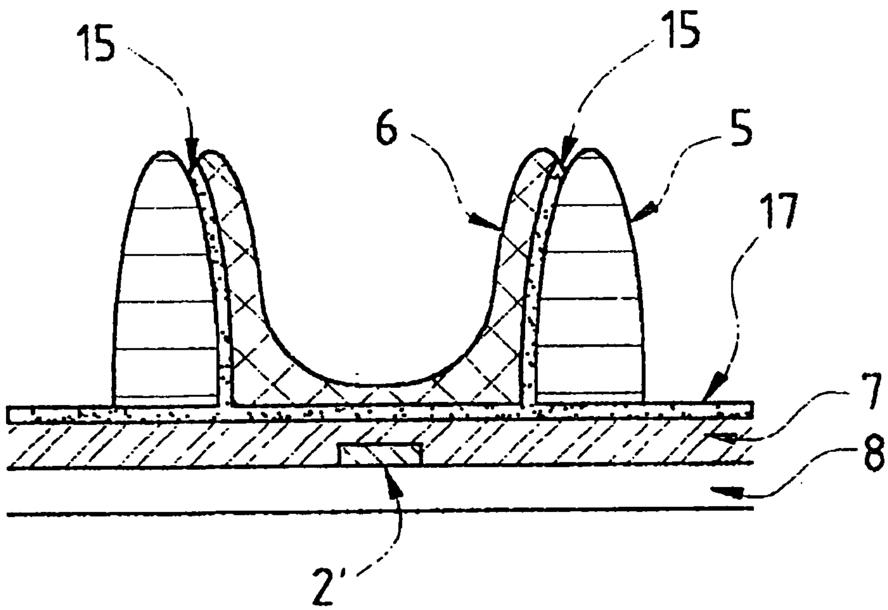


FIG. 5

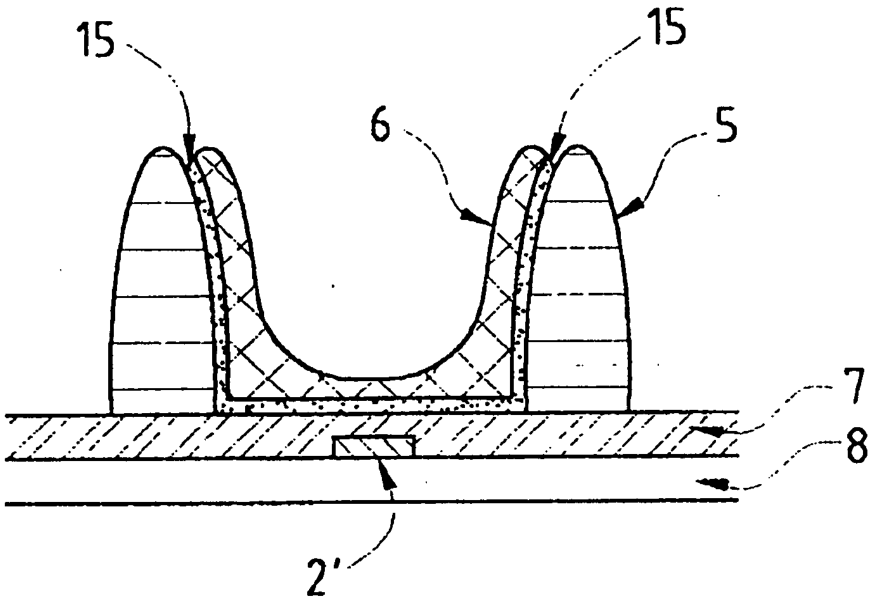


FIG. 6

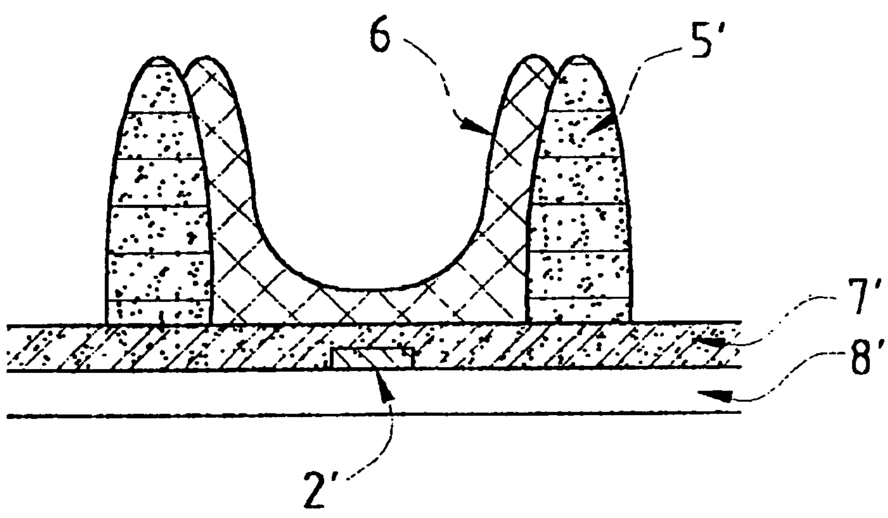
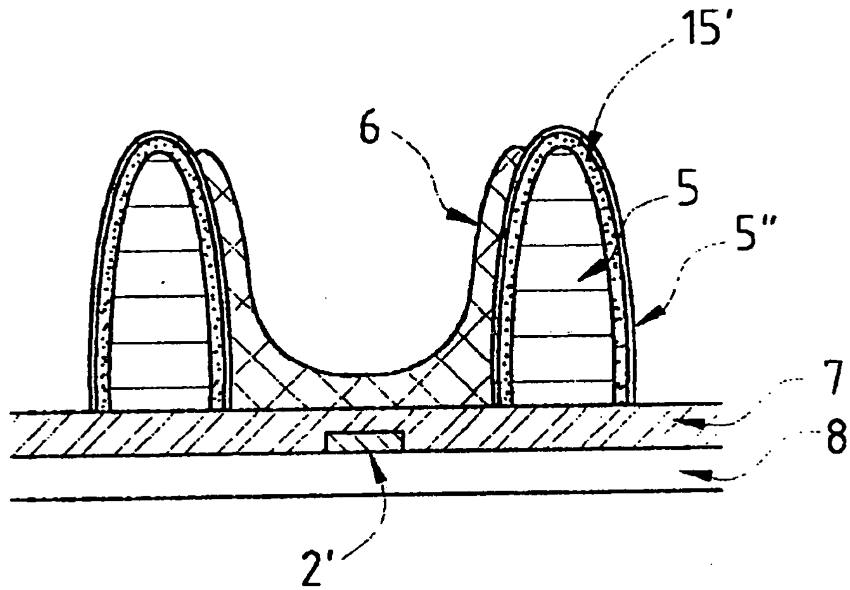


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR00/01339

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H01J 17/49, H01J 11/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimun documentation searched (classification system followed by classification symbols)

IPC7 H01J 17, H01J 11, C09K 11

Documentation searched other than minimun documentation to the extent that such documents are included in the fileds searched

Korean Patents and applications for inventions since 1975
Korean Utility models and applications for Utility models since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search trerms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 93-20521 A (SAMSUNG SDI) 20 October 1993 abstract; claim 3	1, 3, 4
P, X	JP 2000-133148 A (PIONEER) 12 May 2000 abstract; claim 1; page 3, paragraphs [0019], [0023] to [0025], [0027] to [0029]; page 4, paragraphs [0034], [0035]; Figs. 1, 2	1, 3, 4
A	JP 10-208647 A (KANSAI NEC) 7 August 1998 the whole document	1, 3, 4
A	JP 11-282414 A (HITACHI) 15 October 1999 the whole doument	1, 3, 4
A	JP 11-250811 A (NEC) 17 September 1999 the whole document	1, 3, 4
A	JP 10-149776 A (KASEI OPTONICS) 2 June 1998 the whole document	1, 3, 4

[X] Further documents are listed in the continuation of Box C.   [X] See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevence; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 MARCH 2001 (19.03.2001)	20 MARCH 2001 (20.03.2001)

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Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5747

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR00/01339

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-67103 A (FUJITSU) 9 March 1999 the whole document	1, 3, 4
A	JP 9-263756 A (TOSHIBA) 7 October 1997 the whole document	1, 3, 4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR00/01339

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 93-20521	20.10.93	KR 95-6429 B1	15. 6.95
JP 2000-133148	12. 5.2000	None	
JP 10-208647	7. 8.98	None	
JP 11-282414	15.10.99	None	
JP 11-250811	17. 9.99	None	
JP 10-149776	2. 6.98	None	
JP 11-67103	9. 3.99	None	
JP 9-263756	7. 9.97	None	